

REMARKS

This Response filed in response to the Final Office Action dated April 25, 2008.

Claims 1, 3-5, 8-20 and 28-31 are pending in the Application. Claims 1 and 28 have been amended. No new matter has been entered by the amendments, as support for the amendments is found in the disclosure as originally filed.

In the outstanding Office Action, the Examiner rejected claims 1, 3-5, 8-18 and 28-31 under 35 U.S.C. § 103(a) as being unpatentable over Tani (U.S. Publication No. 2003/0145934) hereinafter "Tani" in view of Hillig et al. (U.S. Patent No. 4,917,941) hereinafter referred to as "Hillig et al.", and rejected claims 19 and 20 under 35 U.S.C. § 103(a) as being unpatentable over Tani in view of Hillig et al. as applied to claim 1, and further view of Colegrove et al. (U.S. Patent No. 6,096,669) hereinafter "Colegrove".

Response to Arguments

Applicant places new argument upon the record by asserting that Hillig fails to teach or disclose an interface comprising a nonwoven mat formed of a plurality of chopped ceramic fibers disposed between the plurality of preform lamina. This distinction is discussed further below in the rebuttal of the rejections.

Rejections under 35 U.S.C. 103

A. Claims 1, 3-5, 8-18 and 28-31

The Examiner rejected claims 1, 3-5, 8-18 and 28-31 under 35 U.S.C. § 103(a) as being unpatentable over Tani in view of Hillig.

Specifically, the Examiner stated that

a. Tani teaches a process for producing a fiber-reinforced silicon carbide composite offering high toughness comprising a multiple layer laminate (Abstract). Woven, nonwoven and unidirectional prepregs of silicon carbide fiber are available to reinforce the silicon carbide matrix [0014, 0015]. The voids between the fibers of each layer of the composite are filled with polymeric resins and silicon. The matrix serves to impregnate or infiltrate the spaces between the fibers of the fabric support layers [0019 and 0020]. Following heat-treatment the tow components from a porous silicon carbide matrix that link the fibers of each layer of the laminate (Abstract, [0006]). The laminate of Example 3 comprises two layers of nonwoven silicon carbide fabrics laminated in alternating order creating a laminate combination of nonwoven/woven/nonwoven/woven. Unidirectional fiber prepregs, which comprise continuous

fibers, may replace the woven fabric layers [0014]. Replacing the woven fabric layers of Example 3 with unidirectional fiber prepreg layers creates a ceramic matrix composite laminate with a nonwoven layer in between two layers of unidirectional fiber prepreg. The invention of Tani is silent as to the use of chopped ceramic biers in the creation of the nonwoven fabric layer.

The Examiner then added a secondary reference stating

Hillig et al. teach a fiber and a filament containing ceramic perform comprised of a mixture of discontinuous fibers surrounding a layer of continuous filaments extending through the mixture. The mixture is produced by and infiltrated with a molten ceramic to produce a composite (Abstract). The continuous fibers provide reserve strength to the composite should it crack and the discontinuous fibers provide toughness to the composite (col. 1, line 61-col. 2, line 12). The discontinuous fibers may be chopped silicon carbide fibers or a mixture of different ceramic fibers (col. 3, lines 1-20). The continuous fibers may be made of silicon carbide or a mixture of different ceramic fibers (col. 5, lines 43-49). Hillig et al. also show that it is advantageous for the ceramic matrix to comprise at least 50 percent of the chopped fiber layer (col. 11, lines 10-14). Therefore, claims 12 and 13 are rejected.

The Examiner further stated

The structure of the applied article has a layer containing a plurality of continuous ceramic filaments adjacent a layer of chopped ceramic fibers located in a continuous matrix phase which is adjacent another layer containing a plurality of continuous ceramic filaments (claim 5). A number of chemical species are available for use as the infiltrant to create the continuous matrix including ceramics (col. 4, lines 1-14). The continuous matrix phase is to be distributed evenly throughout the composite to create the instantly claimed infiltrated article (col. 11, lines 6-13). Claim 5 is rejected as the ceramic fibers may have a length of from about 10 to about 2000 microns (0.0004 to 0.08 inches)(col. 3, lines 13-15). Claim 14 is rejected as the ceramic chopped fibers have diameters up to 10 microns (0.0004 inches)(col. 3, lines 10-15).

The Examiner further continued

Claims 8-11 are rejected as the matrix phase of the applied invention is designed to fill the space the between adjacent layers of continuous filaments thereby reducing the number of inter-laminar voids, size and volume fraction of said voids. The most preferred embodiment is a completely pore-free composite (col. 10, lines 61-64).

The Examiner further continued

Since Tani and Hillig et al. are from the same field of endeavor (i.e. fiber-reinforced silicon carbide composites), the purpose disclosed by Hillig et al. would have been recognized in the pertinent art of Tani.

The Examiner then added a motivation statement continuing

It would have been obvious at the time the invention was made to a person having ordinary skill in the art to have made the nonwoven layers of Tani with the chopped ceramic fibers of Hillig et al. and formed a composite without any remaining voids. The skilled artisan would have been motivated by the desire to provide the composite with toughness (col. 1, line 61-col. 2, line 12, Hillig et al.).

The Examiner further continued

Hillig et al. teach a chopped fiber mat thickness of 0.02" (Example 1). Tani and Hillig et al. disclose the claimed invention except for the nonwoven mat thickness of claim 3. Absent a teaching of the criticality of the nonwoven chopped fiber mat of claim 3, it would have been obvious to one having ordinary skill in the art at the time the invention was made to have made a thinner nonwoven mat layer between 0.0001 and 0.0002 inches thick, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233. A thinner nonwoven mat would allow for the stronger unidirectional fiber layers to make up more of the ceramic composite improving its total strength.

Claim 4 is rejected as the discontinuous fibers of the chopped fiber layer of Hillig et al. are randomly oriented and then infiltrated with ceramic matrix.

The Examiner further added

The new limitation of using a "compressed nonwoven mat" between the preform lamina is met by the applied art in that the structure and composition of the claimed article is provided by Tani and Hillig et al. and the "compressed" limitation would not materially affect the structure of the claimed nonwoven mat that is already very thin or distinguish it from the mat of Hillig et al. (0.02" thick).

Applicants respectfully traverse the rejection of claims 1, 3-5, 8-18 and 28-31 under 35 U.S.C. § 103(a).

The following principles of law apply to all section 103 rejections:

(a) [a] patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of [title 35], if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The inquiry into whether the subject matter of a patent application is obvious under section 103 begins with the factual inquiries outlined in *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 148 (1966). The steps for considering these factual inquiries are:

the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved needs, failure of

others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented.

Graham v. John Deere Co. of Kansas City, 383 U.S. 1, 17-18 (1966). The *Graham* factors were recently affirmed by the U.S. Supreme Court's decision in *KSR International Co. v. Teleflex, Inc.*, 127 S. Ct. 1727 (2007). In *KSR*, the Court continued by indicating that "[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *Id.* (cited by MPEP § 2141). In *KSR*, the Court reaffirmed, at least in part, three cases applying this rule: *United States v. Adams*, 383 U.S. 39 (1966) (rendering as obvious the mere substitution of one element), *Anderson's-Black Rock, Inc. v. Pavement Salvage Co.*, 396 U.S. 57 (1969) (rendering as obvious claims with two pre-existing elements combined wherein the combined elements did no more than they would have in separate, sequential operation), and *Sakraid v. AG Pro, Inc.*, 425 U.S. 273 (1976) (rendering as obvious claims that simply arranged old elements wherein each element performed the same function as had been previously performed). Summarizing the above authority, the Court (and the MPEP) reiterated that "rejections on obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR* at 1741 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

Tani, as understood, is directed to a process of producing a multi-layer fiber-reinforced silicon carbide composite having an amount of toughness. Tani discloses at paragraph [0014] that the reinforcement may include nonwoven fabrics or laminates of transversely laid sheet-like unidirectional fiber prepregs may also be used instead of fibrous woven fabrics. Tani further discloses at Example 3 [0034-0035] a process to mold prepregs wherein fiber woven prepregs and fiber non-woven prepregs are laminated in alternate order, and the laminate is molded into a desired shape.

Hillig et al., as understood, is directed to a composite containing ceramic fibers. The composite may be formed by either of two methods. In a first embodiment (col. 2, lines 13-23), the composite may be formed by slip casting a suspension of fibers and liquid vehicle and impressing a layer of continuous filaments into the still wet slip casting, followed by slip casting

a cover layer upon the continuous filaments. The laminate casting is then dried and infiltrated to form the composite. In a second embodiment (col. 2, lines 24-34), the slip casting suspension is first partially dried before the layer of continuous filaments is impressed. Hillig et al. further discloses that the fibers of the suspension may comprise chopped fibers (col. 3, lines 1-6). Hillig et al. further discloses that the composite may be built up of multiple alternating layers.

In contrast, amended independent claim 1, as amended, includes the limitation:

"a plurality of preform lamina, each of the preform lamina formed of directional continuous ceramic fiber in a ceramic matrix; and

a substantially removed interface disposed between the plurality of preform lamina comprising an infiltrated compressed nonwoven mat including a nonwoven mat formed of a plurality of chopped ceramic fibers and a ceramic matrix interposed and compressed between an interface of adjacent preform lamina."

Further in contrast, independent claim 28 as amended includes the limitation:

"a substantially removed interface disposed between the plurality of preform lamina comprising an infiltrated nonwoven mat including a nonwoven mat formed of a plurality of randomly oriented chopped fibers and a ceramic matrix compressively interposed between an interface of adjacent preform lamina."

Further in contrast, independent claim 28, as amended, includes the similar limitation

"an interface disposed between the plurality of preform lamina comprising an infiltrated nonwoven mat including a nonwoven mat formed of a plurality of randomly oriented chopped fibers and a ceramic matrix, the nonwoven mat being compressively interposed between an interface of adjacent preform lamina so as to substantially remove the interface between the adjacent preform lamina.".

These limitations are not met by Tani. Specifically, Tani discloses a composite with alternating layers of woven and non-woven matrix material. Applicant's claimed invention is to adjacent woven matrix layers having an interface therebetween comprising an infiltrated nonwoven mat including a nonwoven mat formed of a plurality of randomly oriented chopped fibers.

Hillig et al. fails to cure the deficiencies of Tani. The Examiner asserts that Hillig et al. discloses a mat formed of chopped fibers. While Hillig et al. may teach that discontinuous chopped fibers were used in the prior art (col. 1, line 61 to col. 2, line 12) as asserted by the Examiner, Hillig et al. fails to disclose using these chopped fibers in a mat. Furthermore, the Examiner discusses "chopped fibers" used as discontinuous fibers of the invention (col. 3, lines 3-20), but further fails to disclose a non-woven mat. The Examiner appears to be interchanging the terms chopped fibers and discontinuous fibers with non-woven mat within the rejection. Furthermore, Hillig et al. teaches that the discontinuous fibers of his invention should be deposited substantially parallel to one another and not in contact (col. 6, lines 24-41). If the Examiner is to maintain this rejection, it is requested that the Examiner point to the section of the disclosure of Hillig et al. which discloses a non-woven mat, the term "mat" as understood in the art to mean intertwined fibers.

Additionally, the combination of Tani and Hillig et al. fails to teach or suggest the following limitations

"the nonwoven mat interposed **and compressed between** an interface of adjacent preform lamina." (emphasis added)

as found in claim 1, and

the nonwoven mat being **compressively interposed between** an interface of adjacent preform lamina " (emphasis added) as found in claim 28.

The present invention requires that the nonwoven mat be compressed between adjacent preform lamina to substantially remove the interface between the adjacent preform lamina. This limitation is nowhere to be found in the disclosures of either Tani or Hillig et al. Furthermore, this limitation goes to the heart of Applicant's invention, the removal of the interface between adjacent preform lamina. The Examiner simply states that these limitations are "met by the applied art in that the structure and composition of the claimed article is provided by Tani and Hillig et al. and the "compressed" limitation would not materially affect the structure of the claimed nonwoven mat that is already very thin or distinguish it from the mat of Hillig et al. (0.02" thick). This is nothing more than hindsight construction. Applicant requests that the

Examiner provide a teaching as to the compression and the removal of the interface as a result thereof if the Examiner is to maintain this position.

Dependent claims 3-5, 8-18 and 29-31 are believed to be allowable as depending from what are believed to be allowable independent claims 1 and 28 for the reasons given above. In addition, claims 3-5, 8-18 and 29-31 recite further limitations that distinguish over the applied art. In conclusion, it is respectfully submitted that claims 1, 3-5, 8-18 and 28-31 are not rendered obvious by Tani in view of Hillig et al. and are therefore allowable.

B. Claims 19-20

The Examiner rejected claims 19-20 under 35 U.S.C. § 103(a) as being unpatentable over Tani in view of Hillig, and further in view of Colegrove.

Specifically, the Examiner stated that

The invention of Tani and Hillig et al. are silent as to the use of multiple layers between the continuous fiber perform lamina.

The Examiner brought in Colegrove to teach

Colegrove et al. teach a preform suitable for use in creating a composite laminate (Abstract). Figure 5 shows an embodiment of the preform comprising a nonwoven layer 20, resin 8, and unidirectional fiber layer 10. The unidirectional fibers may be silicon carbide (col. 4, lines 24-26) and the nonwoven mat may be made of chopped silicon carbide fibers (col. 4, lines 52-55). Multiple plies of the Colegrove et al. invention may be laminated together (col. 5, lines 49-53). The lamination of two preforms of Figure 5 with the nonwoven layers 20 would result in a symmetric article with two nonwoven layer adjacent layers of resin 8, and adjacent two layers of unidirectional layers 10.

Since Tani and Colegrove et al. are from the same field of endeavor (i.e. silicon carbide fiber composites), the purpose disclosed by Colegrove et al. would have been recognized in the pertinent art of Tani.

It would have been obvious at the time the invention was made to a person having ordinary skill in the art to modify the article of Tani and Hillig et al. to include multiple layers of the nonwoven mat of Tani between the layers of directional continuous ceramic fibers. The skilled artisan would have been motivated by the desire to create an article that possesses enhanced thermal properties with the inclusion of additional chopped silicon carbide fibers. The enhanced thermal property allows the composite to have a more uniform thermal expansion, thereby decreasing the thermal stresses that buildup due to mismatched coefficient of thermal expansions between its phases.

Applicants respectfully traverse the rejection of claims 19-20 under 35 U.S.C. § 103(a).

The previous discussion of Tani and Hellig et al. is equally applicable herein.

Colegrove, as understood, is directed to a preform suitable for resin transfer molding, and does nothing to cure the deficiencies of the rejection as discussed above.

Dependent claims 19-20 are believed to be allowable as depending from what is believed to be allowable independent claim 1 for the reasons given above. In addition, claims 19-20 recite further limitations that distinguish over the applied art. In conclusion, it is respectfully submitted that claims 19-20 are not anticipated nor rendered obvious by Tani in view of Hillig et al. and further in view of Colegrove et al. and are therefore allowable.

CONCLUSION

In view of the above, Applicant respectfully requests reconsideration of the Application and withdrawal of the outstanding objections and rejections. As a result of the amendments and remarks presented herein, Applicant respectfully submits that claims 1, 3-5, 8-20 and 28-31 are in condition for allowance. As the claims are not anticipated by nor rendered obvious in view of the applied art, Applicant requests allowance of claims 1, 3-5, 8-20 and 28-31 in a timely manner. If the Examiner believes that prosecution of this Application could be expedited by a telephone conference, the Examiner is encouraged to contact the Applicant.

The Commissioner is hereby authorized to charge any additional fees and credit any overpayments to Deposit Account No. 50-1059.

Respectfully submitted,
McNEES, WALLACE & NURICK

By
/Daniel J. Jenkins/

Daniel J. Jenkins
Reg. No. 59,162
100 Pine Street, P.O. Box 1166
Harrisburg, PA 17108-1166
Tel: (717) 237-5213
Fax: (717) 237-5300

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